Appendix B-7 to the
Mars Exploration Program Plan

Program-Level Requirements

For the

Phoenix Lander - 2007

(Scout '07) Project

September 2004

Change 1, Replacement: April 2005

Table of Contents

1 Introduction and Scope

This appendix to the Mars Exploration Program (MEP) Plan identifies the Science Objectives [Section 2] and the Level 1 Programmatic Requirements [Section 4] and Mission Success Criteria [Section 5] for the development and operation of the NASA-selected Scout 2007 mission entitled Phoenix (PI: Peter Smith, University of Arizona).

This document serves as the basis for mission assessments conducted by NASA Headquarters during the formulation and implementation phases, and provides the baseline for the determination of the science mission success during the operational phases. Changes to requirements contained in this document require approval by the Science Mission Directorate (SMD), NASA Headquarters.

The driving theme of the Mars Exploration Program is to understand the role of water on Mars and its implications for possible past or current biological activity. The Phoenix Mission will pursue this "Follow-the-Water" strategy by conducting in-situ and remote sensing observations that return sets of locally targeted data that will strive to achieve the following objectives.

The original Program-Level Requirements document, dated September 2004, is replaced by this Change-1 document to reflect current NASA and MEP organization as well as approved modified objectives and requirements.

2 Science Objectives for Phoenix

Comment: Taken from current L1 Requirements doc

The Phoenix mission "follows the water" by landing in a region suspected to have a large reservoir of water, in the form of ice. The Mars Odyssey Mission, in particular the Gamma Ray Spectrometer (GRS), discovered a large reservoir of hydrogen, assumed to be in the form of water ice, in the northern high latitudes and the north polar region of Mars. The GRS data suggest that this water ice is accessible within the top meter or less of the surface. Owing to Mars' orbital variations and associated solar heating, there is a possibility that this polar water ice could liquefy periodically, on timescales associated with these orbital variations.

In order to address key questions about the water environment in the north polar region (specifically between 65N and 75N), Phoenix will focus on understanding the current character and history of the water, the aqueous geochemistry within the outer meter of the regolith water-ice mixture, and whether this region is conducive to organisms. Phoenix has four major scientific objectives, covering the areas of atmospheres, physical properties and geomorphology, chemistry and mineralogy, and polar environments and biological potential.

The Phoenix mission has the primary objective of placing a science lander onto the Martian surface at high latitudes to perform in-situ and remote sensing investigations that will characterize the chemistry of the materials at the local surface, subsurface and atmosphere and will identify potential provenance of key indicator elements of significance to the biological potential of Mars, including potential organics within any accessible water ice. The Phoenix payload can conduct imaging at scales from 8 m (descent imager) down to 10 micrometers (optical microscope), atmospheric sounding using lidar, and subsurface profiling and sample acquisition via arm-based trenching. Regolith and ice samples will be characterized for mineralogy, hydrogen manifestation, aqueous chemistry, and the isotopic composition of the atmosphere and of gases evolved from heated samples.

A reference payload to accomplish these objectives was defined in the Concept Study Report. The expected characteristics of the reference payload for the Phoenix mission are given in Attachment A to this Appendix. The payload consists of a Thermal Evolved Gas Analyzer (TEGA), a Microscopy, Electrochemistry, and Conductivity Analyzer (MECA), a Surface Stereo Imager (SSI), a robotic arm with a Robot Arm Camera (RAC), a meteorology package (MET), and the Mars Descent Imager (MARDI).

3 Phoenix Project Definition

3.1 Project Description

The Phoenix project is a Mars Scout mission led by a Principal Investigator (PI) supported by a Project Manager at JPL and personnel at JPL, in academia and industry. The scope of the Phoenix project includes all activities to be undertaken by NASA, the Jet Propulsion Laboratory (JPL), Lockheed Martin, the University of Arizona, and international partners participating in the project (e.g., Canadian Space Agency) to design, develop, test, launch and operate the Phoenix lander to achieve the above objectives. Through its data release procedures and its education/public outreach components, the Phoenix project will execute its objectives in a manner that will convey the excitement and wonder of space exploration to the US taxpayer. In addition, Phoenix plans to make use of critical telecommunications relay capability provided by the MRO and Mars Odyssey spacecraft.

3.2 Project Organization and Management

The Phoenix PI is Peter Smith, from University of Arizona. As PI, Peter Smith is responsible for all aspects of the mission, including E/PO. He has approval authority over the project plan and other project documents. The PI reports any project plan changes or proposed descope options to the Mars program manager and through him to NASA for concurrence. The PI approves the reserve liens but delegates the day to day mission implementation authority to the project manager.

The PI leads a science team consisting of those members in the concept study report at the time of selection. Any change to the science team, requiring additional funding, needs the approval of the Space Science Associate Administrator.

The Phoenix project is an element of the overall Mars Exploration Program whose implementation is managed by the Mars Program Manager at JPL.

Technical program management of Phoenix will be conducted within the structures, policies and procedures defined for the implementation of all projects within the Mars Exploration Program.

These structures, policies and procedures are defined in the MEP Program Plan and are included herein by reference.

The Mars Program Manager located at JPL has the end-to-end responsibility for program implementation and programmatically reports to the Mars Exploration Program Director at NASA Headquarters (HQ) and administratively to the JPL Director. The Mars Program Office directs the JPL Mars Program Directorate in the implementation of the project. The Phoenix Project Manager is administratively located in the Planetary Flight Project Directorate and reports to its Director. Programmatically, the Project Manager is responsible to the Mars Program Manager at JPL. The Phoenix Project Scientist at JPL along with the PI is accountable for the scientific integrity of the mission. The Project Scientist reports administratively to the Chief Scientist in the Mars Program Office at JPL and through him to the JPL Chief Scientist. The Project Scientist, the Project manager and PI will keep an open channel of communications with the NASA Headquarters Scout Program Scientist and Program Executive to ensure they are well-informed.

Comment: I agree that Peter should be in charge here.

The Agency Program Management Council (PMC) is the governing PMC for the Phoenix Project. The JPL Center Director is responsible for certifying the Phoenix Project readiness to the Associate Administrator for the Science Mission Directorate (AA/SMD). The NASA Administrator is the approval authority for the initiation of the Project Implementation Phase, for launch, and for project termination.

3.3 Additional science personnel

NASA may solicit additional science participation in the Phoenix mission (e.g., Interdisciplinary Scientist or Participating Scientist investigations) through future NASA Announcements of Opportunity (AOs) or Research Announcements (NRAs). Such participation will be approved by the AA for Space Science at NASA Headquarters and funded as negotiated between NASA and the Phoenix PI and PM.

3.4 Project Acquisition Strategy

The Phoenix project will be executed in the system contract implementation mode. The Phoenix principal investigator has selected JPL for project management, and has selected Lockheed Martin Corporation to provide the lander spacecraft and associated hardware.

The NASA Kennedy Space Center (KSC) will procure and deliver launch services and spacecraft integration support for Phoenix.

The Phoenix project will support and implement, within its allocated resources, the science investigation proposed in its Phase A Concept Study Report (CSR), while paying attention to the significant findings reported by the Scout Evaluation Board, and communicated to the team upon selection.

Four institutional partners, either under contract to the Phoenix project through JPL subcontracts, or through direct NASA funding, to deliver the mission products:

1. University of Arizona—
   1.1 Direct NASA Funding: Principal Investigator, Payload Interoperability Testbed, Science Operations Center and the focal point for all of the Phoenix Education and Public Outreach activities.
   1.2 JPL Subcontract: TEGA-MS and SSI/RAC instruments
2. JPL—Project Management, Project System Engineering, Mission Design, Ground Data Systems, Payload Management, project-level mission assurance
3. Malin Space Science Systems–Mars Descent Imager (MARDI)
4. Lockheed Martin, Denver (under contract to JPL)–Phoenix spacecraft (hardware. software, test, analysis, etc.), mission design support, operations spacecraft team.

The Canadian Space Agency (CSA), under a NASA-CSA agreement, will provide the meteorological package for Phoenix which includes an upward looking lidar.

The implementation of the project will include spacecraft, instrument and ground system development; launch vehicle acquisition and integration; launch, cruise and on orbit operations, and science team investigations. Mission operations development and post launch activities will be implemented in a distributed, de-centralized manner with University of Arizona, JPL, Lockheed Martin Corporation and the science investigator institutions all providing required capabilities.

To accomplish "feed forward" objectives that support future Mars missions, Phoenix will consider (within available resources and margins) accommodating one technology demonstration experiment:

1. Precision Landing—Phoenix will perform an operational demonstration of aeromaneuvering and guided entry to achieve a 20 km (3 sigma) landing error ellipse on the Martian surface at a high latitude landing site target region.

3.5 Science Data Management Description

The Phoenix PI (UA) is responsible for initial analysis of the investigation data, the subsequent delivery of the data products and software to the Planetary Data System (PDS), the publication of scientific findings and communication of results to the public.

It is NASA policy that investigators do not have exclusive use of data taken during the course of their investigation for any proprietary period. Derived data products shall be archived in the PDS as soon as they are available, on a time scale commensurate with the level of data processing to be identified in the Project Data Management Plan.

Because of their exceptional value for public engagement, representative images will be made available publicly throughout the mission shortly after reception on the ground. Release of

Phoenix data by the science team and instrument leads and by the Phoenix Project shall comply with the policies for release of data and public information presented in the *Mars Exploration Program Data Management Plan*.

4 Phoenix Project and Science Requirements

This section contains specific Level 1 requirements for the Phoenix Mission.

4.1 Phoenix Project Functional Requirements

The Phoenix Project shall fulfill the following functional requirements.

4.1.1 Phoenix will comply with NASA NPR 7120.5.

4.1.2 The Phoenix lander shall be launched between August 1 and August 30, 2007 by a Delta II-2925-9.5, expendable launch vehicle from Cape Canaveral Air Station, USA, and shall land safely on Mars in May-June, 2008.

4.1.3 The Phoenix mission shall use its in-situ science payload and engineering systems to acquire surface-based, locally-targeted observations at a high northern hemisphere latitude landing site for a period of 90 sols.

4.1.4 Phoenix will be compliant with NPD 8020.7, NPR 8020.12 and subsidiary documentation (COSPAR PP Policy) for Planetary Protection purposes.

4.2 Science Requirements for Phoenix

Phoenix will accomplish its science objectives by conducting a program of stationary, in situ science observations and by subsequent analysis of the returned data. Central to the mission objectives of acquiring and analyzing samples is the inclusion of a robotic arm capable of excavating regolith and soil materials, along with delivering samples to two on-board analytical laboratories.

4.2.1 Present Climate

Phoenix will study the polar summer atmosphere and weather, interaction with the surface, and composition of the lower atmosphere around 70° N for at least 90 sols focusing on water, ice, dust, noble gases, and CO_2. Phoenix will determine the atmospheric structure during descent through the atmosphere. In particular:

4.2.1.1 Phoenix shall determine the daily and seasonal variations in weather at the landing site. Weather is defined as temperature, dust opacity, pressure, and humidity.

4.2.1.2 Phoenix shall determine the exchange of water vapor with the subsurface, including D/H ratios of the atmosphere and surface samples, near-surface air Temperature and surface Temperature, and atmospheric water-vapor abundance throughout the mission.

4.2.1.3 Phoenix shall determine the bulk atmospheric composition, including isotopic ratios of 3 major elemental components C, O, and Ar.

4.2.1.4 Phoenix shall measure the acceleration during entry, descent and landing (EDL) to constrain models of the atmospheric density profile.

4.2.2 Digging and Sampling

4.2.2.1 Phoenix shall have the ability to dig a trench to an impenetrable layer, or 50 cm, whichever is reached first.

4.2.2.2 Phoenix shall be able to gather samples from the surface down to the trench bottom, and to transport and deliver these samples to instruments on the deck.

4.2.3 Geomorphology and Physical Properties

Characterize the geomorphology and active processes shaping the northern plains and the physical properties of the near surface regolith, focusing on the role of water. In particular:

4.2.3.1 Phoenix shall image regional and local landforms and surface deposits and place observations in the context of orbital data

4.2.3.2 Phoenix shall identify any subsurface layering and distribution of subsurface water ice.

4.2.3.3 Phoenix shall determine subsurface mechanical properties as a function of depth and correlate with visual, textural, chemical, and mineralogical data

4.2.3.4 Phoenix image data shall be used to determine the morphology, topography, reflectance, and photometric behavior of excavated materials

4.2.3.5 Phoenix shall characterize surface and subsurface physical properties (e.g.., temperature, electrical and thermal conductivity, grain morphologies, weathering, and coatings).

4.2.4 Chemistry and Mineralogy

Determine the aqueous mineralogy and chemistry as well as the isotopic composition of adsorbed gases and organic content of the regolith. Phoenix will verify the Odyssey discovery of near surface H_2O ice. In particular:

4.2.4.1 Phoenix shall measure the concentration and gradient of elements and minerals in the surface and subsurface, particularly organics, salts, hydrated minerals, sulfates, carbonates, oxidants, and other volatile-rich substances, and correlate these with ice

4.2.4.2 Phoenix shall verify the presence and identify the form of H_2O on the surface and within the subsurface and provide this data for validation of models.

4.2.5 Biological potential in the north polar environment

Characterize the history of water, ice, and the polar climate. Phoenix can determine the past and present biological potential of the surface and subsurface environments. In particular:

4.2.5.1 Phoenix shall measure the biological potential of the surface and subsurface environments by determining if liquid water has been present, measuring compounds formed from the biogenic elements, C, H, N, O, P, S, by measuring the concentrations of biologically relevant ions including K, Ca, Mg, Na, and by assessing the redox potential.

4.3 Relay Requirements for Phoenix, including EDL coverage

4.3.1 Phoenix will rely on Mars Exploration Program assets (e.g., Odyssey, MRO) for the nominal relay of all science and engineering data.

4.3.2 Phoenix shall provide telecommunications coverage during all critical events, especially EDL, sufficient to diagnose faults and/or failures should they occur.

4.4 Ground Systems Description

The ground system shall provide for the nominal operations of the science instruments, including both targeting and daily mapping activities. The GDS shall support all science and engineering data during the course of the operational mission. Downlink rates and volumes for science data return shall be based on, but not restricted to, two passes per day of an orbiting Mars asset through the UHF relay capability provided, nominally 50 Mb/sol.

The MOS/GDS shall be capable of releasing acquired images (with limited post processing) within 1 day of receipt on Earth for EPO purposes

4.5 Mission Data Requirements

4.5.1 The Phoenix project shall develop a data management plan to address the total activity associated with the flow of science data, from acquisition, through processing, data product generation and validation, to archiving and preservation. As part of this, each independent science investigation shall develop and implement data management plans for the investigation development, operations and analysis phases, including calibration and instrument operations. This Phoenix Project Data Management Plan and all Phoenix science data management activities shall be consistent with the policy and requirements presented in the document *Mars Exploration Program Data Management Plan*, augmented by policies and requirements presented in the *Scout 2007 Announcement of Opportunity*.

4.5.2 The Phoenix project shall archive Level 0 and Level 1 data to the PDS within 12 months from the end of mission. Imaging data shall be released to the public as level 0 raw images within 2 days of being received at the Science Operations Center. Level 0 and Level 1 imaging data shall be archived within 6 months. The Phoenix project shall archive all other Level 0 and Level 1 data to the PDS within 12 months from the end of mission.

4.6 Cost Requirements

The total costs for the Phoenix project shall not exceed $385.6M RY, including the launch vehicle. This cost is planned as $355.4M RY through development and launch, (Phase A–D) and $30.2M RY for Phoenix operations (Phase E).

4.7 External Agreements

The Phoenix project shall establish formal LOA's between NASA and all foreign partners for the participation, design and delivery of instrumentation, up to and including operations. In order to establish a working environment conducive to free and open exchange of information between Phoenix and the foreign partners, Technical Assistance Agreements (TAA's) will be established with each participating member. Those foreign partners identified to participate in Phoenix include:

Canadian Space Agency (CSA), MacDonald Dettweiler Robotics and Optech Corp – MET Lidar
Max Planck Institute for Sonnensystemforschung (MPS) – RAC
University of Neuchatel, Switzerland —AFM
University of Copenhagen, Denmark — Camera Calibration Target

4.8 Education and Public Outreach

The Phoenix project shall develop and implement an Education and Public Outreach (E/PO) program which is fully in compliance with NASA SMD policy and directives for E/PO. The Mars Exploration Program has a comprehensive program wide E/PO activity. The Phoenix E/PO will take full advantage of this program making sure that it is complementary with it. The Phoenix project E/PO shall be based upon the concept study report and shall address all deficiencies cited by the Concept Study Review Panel. It shall be documented through a detailed E/PO Project Implementation Plan. The Plan shall be submitted for SMD review by the time of the Preliminary Design Review.

5 Phoenix Mission Success Criteria

Based on the Project Functional Requirements [4.1] and Mission Requirements [4.2], the following mission success criteria have been established for the Phoenix Project.

5.1 Full Mission Success Criteria

In order to be fully successful, the Phoenix Project shall:

5.1.1 Land successfully on the surface of Mars and achieve a power safe state.

5.1.2 Acquire a true color (RGB), 360° panorama of the landing site.

5.1.3 Obtain calibrated optical spectra of at least 3 locations that include both rocks and soil.

5.1.4 Provide temperature and pressure measurements throughout landed surface operations at a frequency that determines key atmospheric properties.

5.1.5 Provide samples of the surface soil as well as samples from two depths beneath the surface to both TEGA and MECA.

5.1.6 Use TEGA to analyze at least 3 soil samples to create a profile of H_2O (in the form of hydrated minerals, adsorbed water, or possibly ice at the deepest level) and mineral abundances near the surface. It shall also analyze an atmospheric sample in its mass spectrometer.

5.1.7 Use MECA to analyze the wet chemistry of at least 3 soil samples. It shall also analyze 3 additional samples in its microscopy station.

5.1.8 Document all 9 non-atmospheric samples and their collection locations (before and after sampling) with images.

5.2 Minimum Mission Success Criteria

To achieve minimum success, the Phoenix Project shall:

5.2.1 Land successfully on the surface of Mars and achieve a power safe state.

5.2.2 Acquire a 120 degree monochromatic panorama of the landing site.

5.2.3 Provide samples of the surface soil as well as samples from one depth beneath the surface to either TEGA or MECA wet chemistry.

5.2.4 If TEGA, it shall analyze at least 2 soil samples to create a profile of H_2O (in the form of hydrated minerals, adsorbed water, or possibly ice at the deepest level) and mineral abundances near the surface. It shall also analyze an atmospheric sample in its mass spectrometer.

5.2.5 If MECA, it shall analyze the wet chemistry of 2 soil samples.

5.2.6 Document all non-atmospheric samples and their collection locations with images.

6 Special Independent Evaluation

An Independent Review Team (IRT) will be established to provide an external, project-independent, assessment of the project progress and readiness. Chartered by the Office of the Chief Engineer and the Science Mission Directorate, this team will be managed through the LaRC Independent Projects Assessment Office (IPAO). The team will participate in reviews at project transition gates . To avoid increasing both the cost burden and time demands on the Project, the independent reviews will be combined with the major project reviews. The IRT reports to the Science Mission Directorate, the JPL PMC, and Agency PMC as required. The IRT satisfies the requirement for Independent Assessment (IA), Non-Advocate Review (NAR), Independent Implementation Review (IIR) and Enterprise Independent Review (EIR) teams.

7 Tailoring

None.

Approvals

A. V. Diaz Date
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Acronyms

Comment: Needs work

AA	Associate Administrator
AO	Announcement of Opportunity
CCSDS	Consultative Committee for Space Data Systems
EPO	Education & Public Outreach
DSMS	Deep Space Mission Systems
DSN	Deep Space Network
EIR	Enterprise Independent Review
IND	Interplanetary Network Directorate
IRT	Independent Review Team
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
LaRC	Langley Research Center
LOA	Letter of Agreement
MECA	Microscopy, Electrochemistry and Conductivity Analyzer
MEP	Mars Exploration Program
MET	METeorological
MOU	Memorandum of Understanding
MPD	Mars Program (MEP) Directorate (at JPL)
NAR	Non-Advocate Review
NASA	National Aeronautics and Space Administration
PCA	Program Commitment Agreement
PMC	Program Management Council
PSLA	Project Service Level Agreement
RA	Robotic Arm
RAC	Robotic Arm Camera
SMD	Science Mission Directorate
SSI	Surface Stereo Imager
TEGA	Thermal Evolved Gas Analyzer

Attachment A

Reference Payload

A Reference Payload

We will fly the following payload and anticipate that they will have the following characteristics.

A.1 TEGA (Thermal Evolved Gas Analyzer)

TEGA is a combined thermal and evolved-gas analysis facility which includes a Differential Scanning Calorimeter and a Mass Spectrometer. It will receive targeted samples delivered to it via the robotic arm/scoop. It will also acquire Martian atmospheric samples. The TEGA instrument will have the following attributes:

a) Capable of performing at least 4 measurements (1 atmosphere, 1 surface and 2 subsurface).
b) Determine the water ice abundance in the samples to at least 2% precision.
c) Ability to heat samples to temperatures of at least 800° C and determine mineral species from the temperatures at which they undergo phase changes.

A.2 MECA (Microscopy, Electrochemistry, and Conductivity Analyzer)

MECA is a combined wet chemistry/microscopy laboratory and soil probe. It will measure the geochemical composition and surface microstructure of the soil through a combination of wet chemistry and microscopic observations. The MECA experiment will determine physical and chemical properties of the soil:

a) Within a soil sample placed in a wet chemistry cell containing added water plus calibrants:
    1) Measure the pH
    2) Measure the redox potential
    3) Measure conductivity
    4) Measure the leached inorganic anionic and cationic constituents
b) Within a soil sample placed on the microscope observing apparatus:
    1) Capability of measuring the grain sizes >10μm.
    2) Measure color of the grains.
c) On the surface and in the subsurface using a probe on the robotic arm:
    1) Measure the electrical conductivity of the soil
    2) Measure the thermal conductivity of the soil

A.3 Surface Stereo Imager (SSI)

The Surface Stereo Imager is a multi-color camera. It will provide moderate-spatial-resolution context information for microscopy and Robot-Arm Camera (RAC) and will provide independent information on local geomorphology, climate and regional surface processes. The SSI will have the following attributes:

a) 1 cm resolution (single pixel IFOV) at a distance of 10 m.
b) The ability to determine the spectral properties of features of interest at 8 different wavelengths between the range of 0.4 to 1.0 microns wavelength.

A.4 Robot Arm Camera (RAC)

RAC is a 3-color camera attached to the robotic arm. It will provide imaging of local materials, including those in any trench and in the RA scoop. The RAC instrument will have the following attributes:

a) will be capable of resolving pebbles greater than 2 mm in the within the digging area and on the trench walls.
b) The ability to illuminate an object with R, G, B light.
c) The ability to image samples in the scoop that are to be delivered to on-deck instruments.

A.5 Robotic Arm (RA)

The robotic arm is a sample acquisition device that contains a scoop, ripper tines, and scraping blades. It will be used to acquire targeted samples and to deliver those samples to the TEGA and MECA instruments. In addition, it will be used to position the RAC and the TECP to make detailed measurements of pre and post-digging surfaces, including trenched and scraped areas. The RA will have the following attributes:

a) The ability to dig into dry soils.
b) The ability to provide samples in its scoop to on-deck instruments from the surface and at least two depths below the surface.
c) The ability to determine the mechanical properties of the soil
d) While not designed to dig through solid ice or ice-rich soil the arm will be capable of providing samples of these materials.

A.6 MET Package

The MET package is a meteorology and planetary boundary layer investigation. It will provide information on the characteristics of near-polar meteorology in the boundary layer. MET will have the following attributes:

a) The ability to measure the atmospheric pressure to a precision of approximately ±1 Pascals.
b) The ability to measure atmospheric temperature to approximately ±1°C.

A.7 Mars Descent Imager (MARDI)

MARDI is a descent imager that will observe the surface of Mars during the parachute phase of the entry/descent/landing. The MARDI instrument will have the ability to resolve 50 cm objects at 100 m distance

Attachment B

Instrument Mission Success Matrix

For Reference Only

Instrument	Full Mission Success	Minimum Mission Success
TEGA	1. Analyze at least 3 soil samples to create a profile of H_2O and mineral abundances near the surface. 2. Analyze an atmospheric sample in its mass spectrometer.	*If functioning:** 1. Analyze 2 soil samples to create a profile of H_2O and mineral abundances near the surface. 2. Analyze an atmospheric sample in its mass spectrometer.
MECA	1. Analyze the wet chemistry of at least 3 soil samples. 2. Analyze 3 additional samples in its microscopy station.	*If functioning,** analyze the wet chemistry of 2 soil samples.
SSI	1. Acquire a true color, 360° panorama of the landing site 2. Obtain calibrated optical spectra of at least 3 locations that include both rocks and soil	Acquire a monochromatic, 120° panorama of the landing site, *-as a backup-* Document all non-atmospheric samples and their collection locations
RAC	Document all 9 non-atmospheric samples and their collection locations before and after sampling.	Document all non-atmospheric samples and their collection locations. *-as a backup-* Acquire a monochromatic, 120° panorama of the landing site
RA	Provide samples of the surface soil as well as samples from 2 depths beneath the surface to both TEGA and MECA.	Provide samples of the surface soil as well as samples from 1 depth beneath the surface to *either* TEGA or MECA wet chemistry.
MET	Measure temperature and pressure throughout landed surface operations.	

*Only TEGA *or* MECA is needed for minimum mission success.